

Project Details

ROSES ID: NNH10ZDA001N

Selection Year: 2011

Program Element: Focused Science Topic

Topic: Incorporating Plasma Waves in Models of the Radiation Belts and Ring Current

Project Title:

EMIC Waves in the Inner Magnetosphere: Spatial Distribution and Properties

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Summary:

This proposal is in response to the Living With a Star (LWS) Targeted Research and Technology (TR&T) Solicitation of the National Aeronautics and Space Administration (NASA) under the program announcement/solicitation number: NNH10ZDA001N-LWSTRT.

A better understanding of electromagnetic ion cyclotron (EMIC) waves in the inner magnetosphere is critical for understanding and predicting changes in the near-Earth environment, e.g., the scattering loss of relativistic electrons in the radiation belts as well as energetic ions in the ring current. However, due to the lack of sufficient in situ observations and the incomplete picture of wave growth and effects in the magnetosphere, the spatial distribution and properties of EMIC waves are still poorly understood. The Cluster observations can change this. Taking advantage of the abundant in situ measurements of magnetic field and plasma during the Cluster mission (2001 current), we propose an extensive data analysis study to investigate EMIC waves and associated plasma properties in the inner magnetosphere. Besides the EMIC waves themselves, three crucial EMIC wave-associated plasma properties will be studied: 1) ion heating, which indicates the effect of the EMIC waves, 2) hot anisotropic H⁺, which is the free energy provider of the EMIC waves and serves as a necessary condition for the EMIC wave growth, and 3) cold dense plasma, which plays a catalytic role in the wave generation. In the proposed work, the fundamental science question that will be addressed is:

How do the distributions of hot anisotropic H⁺ and cold dense plasma in the inner magnetosphere control the spatial distribution and properties of EMIC waves, and the resulting ion heating?

To answer this question, we will first obtain a list of all Cluster-observed EMIC wave events and their properties in the inner magnetosphere, then collect lists of wave-associated plasma properties, and next examine the occurrence distributions of all the types of events. In this way, we will be able to identify the plasma conditions that lead to the excitation of EMIC waves, and when and where these conditions are likely to occur in the inner magnetosphere.

The proposed study is expected to improve our present understanding of the spatial distribution and properties of EMIC waves and their interactions with particles. The expected outcome of the proposed research is a detailed occurrence distribution map showing where EMIC waves are likely to be observed over the Cluster orbit in the inner magnetosphere, and what the plasma conditions are when they are observed. The project team, consisting of three scientists from the University of New Hampshire, has the necessary data-analysis resources and experience needed for the successful pursuit of the proposed study.

The outcome of this project is expected to be of high value to NASA interests and programs. In particular, the proposed research is directly relevant to the Focused Science Topics (d) of the 2010 NASA LWS TR&T program: "Incorporating Plasma Waves in Models of the Radiation Belts and Ring Current". By collaborating with other members in the Focused Science Topic Team, we will perform both case and statistical studies of the Cluster-observed events. The key wave and plasma parameters of the EMIC waves will also be used as both input and output to test existing and updated wave theories and models. The results

are crucial to the success of the Focused Science Topic Team.

Publication References:

Summary: no summary

Reference: Zhang, J.-C.; Kistler, L. M.; Mouikis, C. G.; Klecker, B.; Sauvaud, J.-A.; Dunlop, M. W.; (2011), A statistical study of EMIC wave-associated He⁺ energization in the outer magnetosphere: Cluster/CODIF observations, Journal of Geophysical Research, Volume 116, Issue A11, doi: 10.1029/2011JA016690

Summary: no summary

Reference:

Saikin, A. A.; Zhang, J.-C.; Allen, R. C.; Smith, C. W.; Kistler, L. M.; Spence, H. E.; Torbert, R. B.; Kletzing, C. A.; Jordanova, V. K.; (2015), The occurrence and wave properties of H⁺-, He⁺-, and O⁺-band EMIC waves observed by the Van Allen Probes, Journal of Geophysical Research: Space Physics, Volume 120, Issue 9, pp. 7477-7492, doi: 10.1002/2015JA021358